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ABSTRACT

Presented is a two-year associate degree curriculum for Engineering Technology. Specializations are provided in civil, electronics, and mechanical technology. The civil engineering technology specialization facilitates three major areas of study, and mechanical technology includes design and production options. Each curriculum was designed to include an adequate background and as much in-depth training as was considered reasonable in a two-year program. One of the advantages of these curricula is the almost common first year which permits greater flexibility for students in selecting an area of specialization. (Author/DS)

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Associate Degree Curriculum for Engineering Technology

by

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Dammam, Saudi Arabia

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Introduction

This paper presents a two-year Associate Degree Curriculum for Engineering Technology. Specializations are provided in Civil, Electronics and Mechanical Technology. The civil engineering technology specialization facilitates three major areas of study, and mechanical technology includes design and production options. The following definition provided guidance in curriculum development efforts.

> "The American Society for Engineering Education (ASEE) defines an engineering technician as one whose education and experience qualify him to work in the field of engineering technology, which is that part of the engineering field lying in the occupational area between the craftsman and the engineer, at the end of the area closest to the engineer. The engineering technician differs from the craftsman in his knowledge of scientific and engineering theory and methods; he differs from the engineer in that he has a more specialized background and uses technical skills in support of engineering activities." (Armsby, 188)

Each curriculum was designed to include an adequate background and as much in-depth training as was considered reasonable in a two-year program. One of the advantages of these curricula is the almost common first year which permits greater flexibility for students in selecting an area of specialization. This also facilitates a shorter period of retraining as the needs of the individual and/or employer(s) change. The one 4-credit exposure to a chosen specialized curriculum was planned within the first year of study so that a student can make a more informed decision at the end of the first year. If a student decides after one year to change to a different specialization, the 4-credit course

from the new area can be taken during the intervening summer. With this curricula organization, a student can complete one technician curriculum, and in an additional calendar year, he can complete a second technician curriculum. This flexibility should be attractive to all concerned.

It will be noted that only one English Composition course and one communications course are required. However, there are two other courses in each curriculum in which technical writing is a requirement. There are six technical reports required in the Summer Work Experience program. Also in each curriculum there is the problems course taken during the final semester. One of the requirements in this course is the writing of a technical research report.

Little or no consideration was given to institutional or State requirements. It was felt that the school administration is charged with the responsibility of adapting the curricula to such requirements or changing the requirements to accommodate the curricula.

Freshman Year for the 4 Technology Curricula

Courses	Semester	
	First	Second
English Composition	3	-
Social Science Elective	-	3
Mathematics I	3	-
Mathematics II	-	3
Chemistry	4	-
Physics	-	3
Graphics	3	-
Survey in Electronics	3	-
Engineering Methods and Quantitative Measurement		3
Specialized Curriculum Course*	-	4
	16	16

*The following courses are specified for each curriculum.

Civil Technology: Introduction to Civil Technology

Electrical Technology: Direct Current and Alternating Current Circuits

Mechanical Technology (Production and Design): Introduction to Production and Design Technology

Summer Work Experience - 3 Credits

The college will arrange with local industry for on-the-job experience for each student in the technical area in which he is being trained. The student is to have this experience during the summer between the first and second year of his technical education and is to be under the supervision of a coordinator from the college. The student should have as rich and varied opportunities as possible during this work experience.

The objectives of this experience are the following:

1. Provide the student with the opportunity to study an industrial organization by direct and continuous observation.

2. To add incentive and increase student motivation.

3. Provide the student with a first-hand experience of fitting into a work force while under the supervision of the college.

4. Permit the student to write technical reports on his learning experiences which should be less laborious than writing on topics of little or no interest.

5. Provide prospective employers an opportunity to identify students whom they would be interested in employing upon graduation.

Credit for the work experience will be granted provided the following requirements are satisfactorily observed.

1. The work experience position is approved by both the student's advisor and the program coordinator before the student begins the job.

2. The student works full-time on the approved job for a minimum of 6 weeks (240 hours) for 3 credits.

3. The student submits a technical report each week (6 reports) selected from the following topics and approved by the program coordinator. The style and format of the reports shall be prescribed and under the direction of the coordinator. The last of these reports shall be a comprehensive report relating the experience to the work experience objectives.

    1. Company Directed Training and incentive Educational Programs.

    2. Company Safety Program.

    3. Company hiring, firing, promotion, and retirement policies.

    4. Product Quality Control.

    5. History of Company (Plant) and prospects for the future.

    6. The effects of automation, and technical advances on production and the work force in this company or plant.

    7. The organization and company policies concerning sales and distribution.

    8. The role of Research and Development in the company.

    9. Factors which control production and work scheduling.

    10. Company procedure for preparing contract bids and the relative competitiveness of the company.

    11. Labor organization affiliation and the advantages and disadvantages of such affiliation to the work force.

(Required) 12. The degree to which the work experience met the objectives of the experience.

13. Other topics selected or approved by the work experience coordinator

4. The student and his employer are visited on the job site at least twice during the six weeks period by the coordinator of the program who then prepares an evaluation of the student's experiences.

Civil Technology

Sophomore Year

Courses	Semester First	Semester Second
Social Science Elective	3	-
Communication Skills	-	3
Mechanics (Statics and Dynamics)	4	-
Engineering Materials	3	-
Legal and Economic Aspects of Civil Engineering	-	3
Plane Surveying	3	-
Reinforced Concrete Construction	-	4
Soils and Foundations	-	3
Technical Elective*	3	-
Technical Elective*	-	3
	16	16

*The following Technical Electives facilitate majoring in different areas of Civil Engineering.

Highway Major:
- Roadway Design and Construction
- Map Drafting
- Drainage and Geology

Structural Major:
- Architectural Drafting and Construction Laboratory
- Advanced Architectural Drafting
- Water Supply and Wastewater Control

Sanitation Major:
- Drainage and Geology
- Water Supply and Wastewater Control

Electronics Technology

Sophomore Year

Courses	Semester First	Semester Second
Social Science Elective	3	-
Communication Skills	-	3
Vacuum Tube Theory	3	-
Semi-Conductors	3	-
Instrumentation (Theory and Use)	3	-
Industrial Electronics	3	-
Electronics Communication	-	4
Computer Logic and Theory	-	3
Special Problems in Electronics	-	5
	15	15

Mechanical Technology (Design Option)

Sophomore Year

Courses	Semester First	Semester Second
Social Science Elective	3	-
Communication Skills	-	3
Manufacturing Methods I	3	-
Manufacturing Methods II	-	3
Mechanics (Statics and Dynamics)	4	-
Engineering Materials	3	-
Basic Mechanicms and Kinematics	3	-
Machine and Tool Design	-	5
Design Problems	-	5
	16	16

Mechanical Technology (Production Option)

Sophomore Year

Courses	Semester	
	First	Second
Social Science Elective	3	-
Communication Skills	-	3
Manufacturing Methods I	3	-
Manufacturing Methods II	-	3
Mechanics (Statics and Dynamics)	4	-
Engineering Materials	3	-
Methods and Operational Analysis	3	-
Plant Layout and Materials Handling	-	3
Process Planning	-	3
Production Problems	-	4
	16	16

Last Semester's Problems Course

It will be noted that each of the four curricula has a problems course included during the last or fourth semester. The following is a description of what should be included in such a course.

Each curriculum should have its own course if possible, so that the problems will be related to all the students involved. The class shall meet regularly in a seminar type organization. Each student identifies an acceptable problem and possible procedure to pursue the problem. All members of the class are expected to help identify possible difficulties as well as suggestions on how the procedure might be improved. All students are expected to help each other in whatever way they can.

The problems pursued should be technical problems, production problems, personnel problems, management problems, or other problems of interest to the student and of value to the training of the students in the class. Each student will prepare and submit a complete research report according to a prescribed format and style. Each student will prepare and duplicate for other classmates an abstract of his study.

After the problems and procedures are refined, the class time will be spent resolving difficulties which arise in pursuit of the problems, techniques in organizing the research report, footnoting systems, organization and style of bibliography, overall format of a research report, as well as films and presentations related to research and research reporting.

The culminating activity in the class sessions will consist of each student giving a formal presentation of his study so that all students can benefit from his experience. It is suggested that the formal documents should be made available to students interested in studying their classmates' problems more closely.

The benefits of such a course are numerous. The students have an opportunity to do systematic research including explicitly stating a problem, a purpose, needs, assumptions, limitations and procedures. The students also have an opportunity to locate resources both from the literature and from industrialists. They have the experience of organizing their material and findings into a formal document and the experience of preparing and presenting, with whatever visuals needed, a presentation to an audience which is similar to a researcher reporting to industrial management.

Another distinct advantage of such a course is that the students pursue problems in many different directions from which the entire class benefit as contrasted to the typical course where all students pursue the same content and there is less learning from each other. It also permits a student to become quite expertise in some area of his technology which is of special interest to him.

The research document should also be of value to the student in another way. The student can present it to a prospective employer as a sample of his capabilities in identifying and solving a problem as well as his ability to do technical writing.

Courses common to all four curricula

Chemistry (4 credits): Basic laws and theories of chemistry, balancing chemical equations, the periodic table, molecular and atomic structure, bonding, introductory metalography, properties of solids, liquids and gases.

Communication Skills (3 credits): Need for communication, dynamics of language, organization of material, review of related material, technical writing, oral reporting, and communication techniques and materials.

Engineering Methods and Quantitative Measurement (3 credits): Fundamentals of measurement, accuracy, precision error, basic standards (time, frequency, temperature, etc.), basic detector-transducer elements, terminating devices (meters, scopes, counters, etc.), applied measurement (count or events, displacement, strain, force, torque, pressure, flow, temperature, velocity, acceleration, vibration, shock, etc.), and industrial applications of computers.

English Composition (3 credits): Grammar, sentence structure, themes, letters, spelling, use of the library and reference material, documentation of research (footnotes and bibliography), selected readings in literature.

Graphics (3 credits): Graphic language, lettering techniques, sketching and shape description, orthographic projection, multiview drawings, sectional views, auxiliary views, conventional practices, isometric drawing, oblique drawing, charts and graphs, and blue print reading.

Mathematics I (3 credits): Fundamentals of Algebraic operations, equations and formulas, plane and solid mensuration, exponents, radicals, ratio, proportion, variation, logarithms, slide rule, graphing data, solution of right triangle and oblique triangles.

Mathematics II (3 credits): Basic trigonometric identities, trigonometric curves, the straight line, circles, conic sections, graphical solutions of simultaneous equations, three dimensional space and the coordinate system, vector analysis, vector operations, graphical differentiation, and graphical integration.

Physics (3 credits): Matter and measurement, matter and molecules, liquid pressure, Archimedes' principle, specific gravity, atmosphere and air pressure, concurrent forces, parallel forces, motion, Newton's laws, work, power, energy, simple machines, heat and expansion, heat transmission, heat measurement, sound, light, and optics.

Survey in Electronics (3 credits): Sources of electricity, electrical measurement, simple series and parallel circuit analyses, electro-mechanical circuit construction considerations, simple control devices used in electronics.

Social Science Electives

Economics (3 credits): Economic forces and indicators, natural resources, capital and labor, business enterprises, factors of industrial production cost, price, competition, monopoly, distribution of income, personal income management, insurance, personal investments, social security, money and banking, government expenditures (Federal, State, local), fluctuations in production, employment patterns, and perspective of economy.

History of Technology (3 credits): Handicraft systems, guild system, central workshop, factories, spread to America, development of power and prime movers, inventions and patents, interchangeable parts, mass production, precision, standardization, automation, and cybernetics.

Industrial Organizations and Institutions (3 credits): Labor in an industrial world, management in an industrial society, collective bargaining, dynamics of the labor market, wage determination, and the balance sheet of labor-management relations.

<u>Courses common to the Mechanical Technologies and Civil Technology</u>

Engineering Materials (3 credits): Extraction of metals from ore, metallic structures, testing of engineering materials, effects of temperature and humidity on materials, corrosion, alloying, heat treating, ferrous and non-ferrous metals, concrete, inorganic cementing materials, minerals, rocks, clay and

related materials, plastics, rubber, wood, organic coatings, beams, shear force and bending moments, stress and strain, torsion, combined stresses, columns, and joists.

Mechanics -- Statics and Dynamics (4 credits): Fundamental principles of mechanics, forces and force systems, free-body diagrams, couples, equilibrium, moments, structures, trusses, frames and machines, friction, centroids, center of gravity, moment of inertia, motion and velocity, force and acceleration, curvilinear motion and rotation, work energy, and power.

Specialized courses for Civil Technology

Introduction to Civil Technology (4 credits): Role of the engineering technician in civil technology. Applications of mathematics, science, and scientific methods to engineering practices; analysis of data, error analysis, inspection methods; materials used in construction (wood, concrete, metals, ceramics, plastics, organic, etc.); construction methods, material use and handling, safety procedures, occupational opportunities and options for majors in civil technology.

Legal and Economic Aspects of Civil Engineering (3 credits): Organization and operation of an architect's, engineer's, or contractor's office; office practices, estimating, planning and scheduling; accounting methods, general administration, data processing, codes, restrictions, standards, and legal documents associated with construction; restrictions, standards and requirements established by law to govern construction; interpretation and preparation of specifications, bidding procedures, bonding, letting, awarding of contracts, torts, negligence, trespassing, violation of the right of lateral support, workman's compensation, and employee injuries; law of real property, ownership, easements, licenses, boundaries, and eminent domain.

Plane Surveying (3 credits): Types of surveys, fundamentals of plane surveying, measurement of distances and angles, azimuths and bearings, theory and practice

of leveling, use and care of instruments (tape, chain, rod, transit, level, and alidade), calculation of traverse, areas, volumes, curves, stadia and plane table mapping, topographic and route surveying.

Reinforced Concrete Construction (3 credits): Cement, mortar, concrete, proportioning and testing concrete specimens, properties of materials and types of reinforcing steel, concrete columns, beams and slabs, construction procedures, forming and shoring, prestressing, reinforcing elements, precast, finishing and curving.

Soils and Foundations (3 credits): Properties of soils and rocks, testing demsities, moisture content, compaction, permeability, shearing resistance and stability, subsurface exploration techniques and equipment, foundation types and construction methods, design of foundation elements and field interpretation.

Major option courses for Civil Technology

Architectural Drafting and Construction Laboratory (3 credits): Residential design and construction, drafting techniques, area planning, designing the exterior, location plans, floor plans, foundation plan, electrical and mechanical plans, elevations, sections, details, framing plans, pictorial drawings, schedules, specifications, estimating, financing, use of manufacturer's catalogues and literature, structural tables and building codes, methods of house construction and structural members, model construction. A practical residential design and drafting problem is utilized.

Advanced Architectural Drafting (3 credits): Commercial building design and construction, (merchandising facilities, offices, banks, hospitals, restaurants, motels, shopping centers, churches, etc.) structural systems, curtain wall system, steel frame and concrete construction, design of beams, columns, shafts and trusses, interrelationship of various types of drawings required and the development of the complete architectural plans.

Drainage and Geology (3 credits): Hydraulics of flow in pipes and open channels, fluid mechanics, piping of water supply and sewage, transfer of liquid products, hydrology of drainage areas, geology of streams, drainage of storm water runoff, stream-flow analysis, drainage structure design and procedures, pump design and selection.

Map Drafting (3 credits): Classification of maps, map scales, symbols, titles, contour lines and profiles, plotting a map traverse details and cross section, photogrammetry, photointerpretation, measurements and calculations, map proportions, and mosaic construction.

Roadway Design and Construction (3 credits): Elements of transportation roadways, their design and function. Roadway foundations, pavement types, pavement surface properties, composition and design of flexible pavements, structural design of concrete pavements, sub-grade construction, railroad track and bed, construction procedures and equipment, mapping from field notes, computation of curves and earthwork. A comprehensive location-construction design problem parallels course resulting in completed drawings, calculations, estimates, etc.

Water Supply and Wastewater Control (3 credits): Water sources, water demand, water storage, storage effect on water, water purification, raw water transmission, watershed protection, water quality evaluation, water distribution design, wastewater collection, wastewater treatment, effects of liquid wastes on streams and lakes.

Specialized courses for Electronics Technology

Computer logic and theory (3 credits)
Number theory and basic logic is combined with the theory and circuitry needed in analog and digital computer operation.

DC and AC Circuits (4 credits): Basic theory and application with laboratory experience in direct current circuits sources of electrical energy, alternating current circuits, inductance, capacitance, transformer theory, meter use, basic oscilloscope use, and the electro-mechanical aspects of circuit construction.

Electronics Communication (4 credits): A course including the theory and application of television, radio, telemetry, micro wave and associated antennae theory. Micro wave lazer and mazer theory will be explored.

Industrial Electronics (3 credits): A study of the vacuum tube and semi-conductor controls that are used in industry. Switching, counting, fusing, heating, and inspection circuits are included with industrial communication and computing circuits.

Instrumentation - theory and use (3 credits): The theory and operation of common check-out and source type of equipment including signal generators, tube and transistor testors, volt meters, oscilloscopes, and communication alignment equipment.

Semi-Conductors (3 credits): Semi-conductor theory and operations including diodes, transistors, and integrated circuits. Mechanical and electrical considerations in design applications are to be considered. Common rectifier, amplifier, oscillator and mixing functions are to be examined.

Special Problem in Electronics (5 credits): A situation where the student can apply his technical skills in a research project in electronics. The student under the guidance of the instructor will develop a major research project appropriate to his interest and needs in industry.

Vacuum Tube theory (3 credits): Basic theory, functions and applications of the vacuum tube as an amplifier, mixer, rectifier, and oscillator. Tube theory with its related circuitry to understand operation and limitations.

Special Courses for Mechanical Technology (Production and Design Options)

Production and Design Technology (4 credits): The role of the engineering technician in mechanical design and industrial production. The application of mathematics, science, and scientific methods to engineering practices. Analysis and presentation of experimental data, flow charts, graphing of data, error analysis, the normal curve, statistical operations, probability, inspection methods, quality control, time and motion study, the deisgn process, product designs, systems designs, factors influencing design (human, material, economic, physical, etc.). Safety. Occupational opportunities in mechanical design and industrial production technology.

Manufacturing Methods I (3 credits): Fundamentals of machining materials. The lathe and lathe tools, (turning, boring, reaming, thread cutting, taper turning, etc.). Shapers and planers, drilling and boring machines, milling machines and cutters, sawing, broaching.

Manufacturing Methods II (3 credits): Foundry practice, patterns, sand casting, die casting, special casting processes, heat treatment of steel, hot forming metals, cold forming metals, welding, brazing, soldering, powder metallurgy, grinding and abrasives, plastics molding, specialized processes with non-metallic materials.

Courses for Design option of Mechanical Technology

Basic Mechanisms (3 credits): Displacement, velocity, acceleration, instant centers, linkages, plane motion, slider crank mechanism, cam displacement diagrams, disc cams, misc cams, rolling contact, spur gears, helical gears, worm gears, bevel gears, gear trains, flexible connectors, misc. mechanisms, descriptive geometry and machine drawing applicable to the above mentioned topics.

Design Problems (5 credits): Design considerations (specifications, power, space, weight, cost, strength, rigidity, lubrication, reliability, durability, safety, economy, patent status, appearance, manufacturing methods, interchangeable parts, use of standard parts, servicing, etc.), application of mathematics to design, working and assembly drawings related to design, design projects.

Machine and Tool Design (5 credits): Review of strength of materials, threaded fasteners, rivets, keys, pins, welds, couplings, clutches, shafts, bearings, belts, pulleys, gears, cams, cranks, the screw, fits, finishes, springs, cutting tools, gauges, jigs and fixtures, punches and dies, turret lathe tools, working detail and assembly drawings related to machine and tool design. Computer applications to design.

Courses for Production option of Mechanical Technology

Methods and Operations Analysis (3 credits): History of methods engineering, process charts, operations analysis, motion study, micromotion and photo memory motion study, time systems, factory cost, equipment used in time study, elements of time study, performance rating, allowances, standard or allowed time, standard data and formulas, work sampling, wage payment plans. Computer applications to production.

Plant Layout and Materials Handling (3 credits): Introduction and definition of problems, types of plant layouts, factors that influence plant layout, materials handling, planning the layout.

Process Planning (3 credits): The process planning function, process and operation selection, designing for manufacture, equipment planning and tooling selection, process planning the job, case problems.

Production Problems (4 credits): Cost, estimating methods, cost estimating elements, production activities, quantitative analysis.

Course Design

A committee of engineering technology educators, industrial representatives, and government representatives suggested the following definition of an engineering technology curriculum:

> "An engineering technology curriculum is a planned sequence of college-level courses, usually leading to an associate degree, designed to prepare students to work in the field of engineering technology." (McGraw, 395)

The term "college-level" in the above definition indicates the attitude with which the education is approached, the rigor and degree of achievement demanded of the student, and not necessarily that the courses are transferable to baccalaureate programs. Engineering technology curricula differ significantly from two-year pre-engineering curricula. The two years pre-engineering curriculum consists of primarily mathematics, science, and general education courses to be followed by an additional two years of engineering education. The engineering technology curriculum, on the other hand, must introduce specialized technical courses early in the program if it is to produce a competent technician in a relatively short period of time.

> "Because of the stringent demands of time and also because of a necessary emphasis on application of principles rather than on derivations, courses must usually be designed specifically for the engineering technology curriculum rather than selected from those designed for longer curricula." (McGraw, 395)

The content of the courses in these curricula was considered appropriate for the specialized engineering technology students. If a course is taught by a professor qualified in the major area and the course is available to other transfer students, it might be possible that the course would be transferable to a baccalaureate program. For example, if the chemistry course is taught by a chemistry professor and it is available to other transfer students, it is possible that the course could be transferred to a baccalaureate program. However, one should not conclude that this chemistry course is the first chemistry course in a sequence of college-level chemistry courses. The content of the chemistry course in these curricula is a composite of college-level chemistry applicable to engineering technician education. This chemistry course might be acceptable for a baccalaureate program requiring one chemistry course, but the content is not what is typically included in a college-level general chemistry I course.

The same position should be taken in relation to the transferability of any course. Only after careful comparison of the content of the two courses should one draw conclusions concerning their equivalence. It would be totally unfair to a transfer student if a course would be accepted for transfer which would hinder his educational progress. On the other hand, it would be unfair to the engineering technology student to generalize the courses to accomodate the transfer students.

Recognizing the above warnings and the variations among baccalaureate curriculums, the following list of possible transfer courses is suggested with reservations.

English Composition	probably
Communication Skills	possibly
Economics	possibly
History of Technology	possibly
Industrial Organizations & Institutions	unlikely
Chemistry	possibly
Physics	possibly
Mathematics I & II	unlikely
Graphics	unlikely
Survey in Electronics	unlikely

If a student is capable of comprehending the more abstract concepts, can readily apply the abstractions to practical problems, and is desirous of later transferring to another institution for a four-year degree, a number of alternate courses would be appropriate. The following suggestions are proposed alternates for those aspiring to a four-year degree.

Two-Year Terminal Courses	Alternatives Transferable to A Four-Year Degree Curriculum
Math I & II	College Algebra, Trigonometry, Analytic Geometry
Economics	Principles of Economics
Chemistry	General Chemistry
Physics	General Physics

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